

# A Conceptual Model of Emergency Department Crowding

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Emergency department (ED) crowding has become a major barrier to receiving timely emergency care in the United States. Despite widespread recognition of the problem, the research and policy agendas needed to understand and address ED crowding are just beginning to unfold. We present a conceptual model of ED crowding to help researchers, administrators, and policymakers understand its causes and develop potential solutions. The conceptual model partitions ED crowding into 3 interdependent components: input, throughput, and output. These components exist within an acute care system that is characterized by the delivery of unscheduled care. The goal of the conceptual model is to provide a practical framework on which an organized research, policy, and operations management agenda can be based to alleviate ED crowding.

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## INTRODUCTION

Emergency department (ED) crowding has become a major barrier to receiving timely emergency care in the United States. Patients who present to EDs often face long waiting times to be treated and, for those who require admission, even longer waits for an inpatient hospital bed. Because ED crowding is a reflection of larger supply and demand mismatches in the health care system, the problem cannot be solved by examination of the ED in isolation. To find solutions, we must examine ED crowding in the context of the entire delivery system by using reliable methods to understand, measure, and monitor system capacity.

We present a conceptual model of ED crowding to help administrators, researchers, and policymakers understand its causes and develop potential solutions. The conceptual model partitions ED crowding into 3 interdependent components: input, throughput, and output. Although factors that originate in many parts of the health care system contribute to ED crowding, the model focuses on this problem from the perspective of the ED. We do not intend to describe all the potential causes of this complex issue. Rather, our goal is to provide a framework that will facilitate a systematic understanding of the problem. After discussing a definition of ED crowding and the overall acute care system, we present the model's components and describe how it could guide research and operational and policy solutions for ED crowding.

The lack of consensus definitions of ED crowding has been a challenge for researchers, clinicians, administrators, and policymakers.<sup>1,2</sup> In 2002, the American College of Emergency Physicians assembled the Crowding Resources Task Force to develop a guide to help American College of Emergency Physicians chapters respond to the problem. The task force developed the following definition of ED crowding, which we have adopted for this article.

Emergency department crowding: A situation in which the identified need for emergency services outstrips available resources in the ED. This situation occurs in hospital EDs when there are more patients than staffed ED treatment beds and wait times exceed a reasonable period. Crowding typically involves patients being

monitored in nontreatment areas (eg, hallways) and awaiting ED treatment beds or inpatient beds.

Crowding may also involve an inability to appropriately triage patients, with large numbers of patients in the ED waiting area of any triage assessment category.<sup>3</sup>

Other authors have offered potential definitions of ED crowding and described factors that are most likely to contribute to the problem. Schull et al<sup>2</sup> used an expert panel to identify factors that were deemed key determinants of ED crowding. They developed a conceptual model of ED crowding that grouped potential causes of crowding into 4 areas: community, patient, ED, and hospital determinants. This group identified ambulance diversion as the most useful operational definition and proxy measure of ED crowding; however, because ambulance diversion is not an option for many hospitals, and because EDs have widely variable thresholds for diverting ambulances, we decided that this definition is not generalizable to ED crowding in the United States. Schull et al also excluded factors such as the availability of primary care in the community as an important determinant of ED crowding. However, their study was based on the Canadian health care system, where universal access to primary care is the norm. Our goal is not to prioritize potential causes of ED crowding but to provide a general conceptual framework that can be used to study the causes and consequences of ED crowding, as well as potential solutions.

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## THE ACUTE CARE SYSTEM

The input-throughput-output conceptual model applies operations management concepts to patient flow among health care sites that we refer to as the acute care system. We broadly define the acute care system to include any delivery system component that provides unscheduled care (Figure 1). This definition is a practical way of identifying the components of the health care system that contribute to, or are affected by, ED crowding. One important feature of the acute care system is its interaction with the delivery of chronic and preventive care. The chronic care system and the acute care system represent 2 sides of the same coin. They are both essential components of the overall health care system, and

they have many characteristics in common; however, they also have important functional distinctions that are not based on the site of care or on patient characteristics. For example, ambulatory care clinics routinely deliver scheduled services of all kinds, while simultaneously providing unscheduled appointments. Likewise, patients with chronic conditions often require care in EDs for acute exacerbations of those conditions, especially when their overall care is poorly organized. The distinction between acute and chronic care delivery is therefore a function of the urgency of the demand for care and the health system's response. This functional distinction is noteworthy because the organizational and supply characteristics for chronic care delivery are different from those required to provide unscheduled care.

## INPUT COMPONENT

The input component of ED crowding in our conceptual model includes any condition, event, or system characteristic that contributes to the demand for ED services. This portion of the conceptual model has properties that are similar to existing models of health care use. For example, Andersen and Laake's<sup>4</sup> Behavioral Model of Healthcare Utilization describes 3 factors that affect use: patient need for health care services, predisposing factors that affect an individual's likelihood of seeking care, and enabling factors that affect an individual's ability to receive care.<sup>4</sup> The inter-

action of these factors has a strong influence on the location and timing of health care use. Although our model does not attempt to address patient-level factors that contribute to decisions to seek ED care, it does describe interactions among components of the health care system and community that affect ED use.

In addition to the factors described in Andersen and Laake's model,<sup>4</sup> an understanding of ED input must include the recognition that there are at least 3 general categories of care delivered in the ED: (1) emergency care; (2) unscheduled urgent care; and (3) safety net care (Figure 2). The input component of our model highlights these categories.

### Emergency Care in the ED

The ED's most visible and indispensable role in the community is the treatment of seriously ill and injured patients.<sup>5</sup> Recent evidence indicates that the proportion of seriously ill and injured patients may be increasing. In an article based on data from California, Lambe et al<sup>6</sup> reported a 59% increase in the proportion of ED cases classified as critical care visits during the 1990s. This trend may be a partial explanation for the recent increase in ED crowding in many parts of the country.<sup>7,8</sup>

The ED frequently serves as a referral site for other providers when they determine that patient stabilization and hospital admission are required. These patients may be referred from urgent care centers, skilled nursing facilities, home health care providers, hospitals, ambulatory clinics, and other sites. Although ambulatory clinics can admit patients with straightforward problems directly to the hospital, they often refer patients with complex problems to the ED for stabilization, triage, and an initial diagnostic evaluation before admission. The concentration of diagnostic and therapeutic technologies available to the ED may contribute to these referral patterns for ambulatory patients.

### Unscheduled Urgent Care in the ED

The ED provides a significant amount of unscheduled urgent care, often because there is inadequate capacity for this care in other parts of the acute care system. Many times, patients are sent to the ED because their clinic cannot quickly treat them for an acute problem

**Figure 1.**

*The acute care system includes the components of the health care system that contribute to, or are affected by, ED crowding. The common link among these services is that they are delivered as unscheduled care.*

#### The Acute Care System

- Unscheduled ambulatory care (physicians' offices and ambulatory care clinics)
- Urgent care services
- ED care
- Hospital and physician services required to care for ED patients (eg, on-call services)
- Inpatient services for patients admitted from the ED
- Out-of-hospital care (emergency medical services)

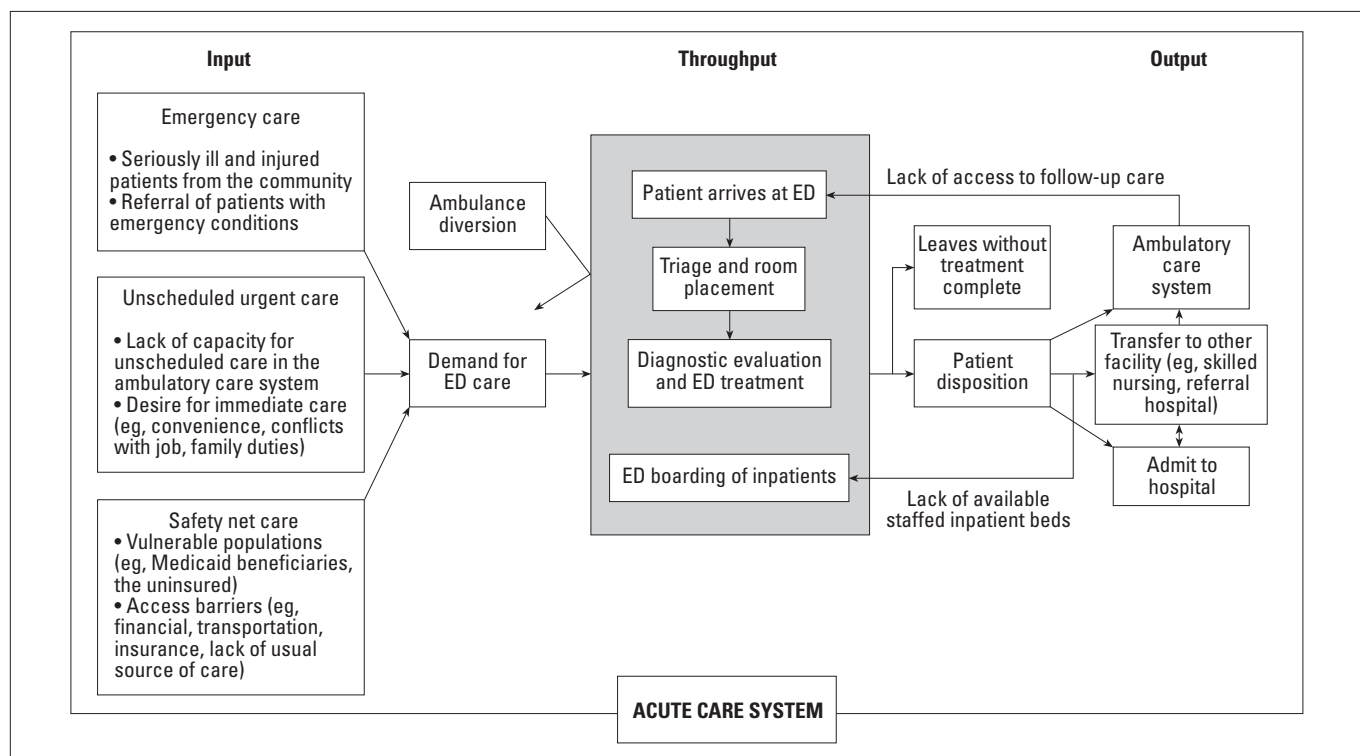
(or an acute exacerbation of a chronic problem) or because other sources of after-hours care are unavailable.<sup>9</sup> Alternatively, patients may schedule an appointment for an acute condition but come to the ED because their symptoms worsen before they can be treated. Although some ambulatory care systems have had success providing same-day appointments with a scheduling system called advanced access,<sup>10,11</sup> the delay for an acute appointment is often longer than patients are willing or able to wait. The convenience of same-day care also influences patient decisions to seek ED care. Even if patients must wait to be treated in the ED, the availability of after-hours care may create fewer conflicts with employment, educational, and family responsibilities.<sup>12</sup>

### Safety Net Care in the ED

The relationship between the ED and vulnerable populations highlights the “safety net” role that EDs play in the

community.<sup>13</sup> Although the ED shares this role with other safety net providers and clinics in most communities, it often is the only open door for patient populations that experience substantial barriers to accessing unscheduled care. Disproportionate numbers of Medicaid beneficiaries and uninsured individuals frequently rely on the ED as their usual source of care, often because cost or access barriers interfere with receiving care elsewhere.<sup>14,15</sup> The ED is not only a safety net for the community but also serves an important safety net function for the rest of the health care system.<sup>16,17</sup> When other medical care options in the system are exhausted, the ED is sometimes the only alternative for acute care. Recent reports from the Institute of Medicine and the General Accounting Office indicate that ED crowding is more severe in communities with higher numbers of uninsured residents.<sup>18,19</sup> These findings reinforce the important safety net role that EDs play in the community.

**Figure 2.**  
The input-throughput-output conceptual model of ED crowding.



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## THROUGHPUT COMPONENT

The throughput component of the model identifies patient length of stay in the ED as a potential contributing factor to ED crowding. This part of the model highlights the need to look internally at ED care processes and modify them as needed to improve their efficiency and effectiveness, especially those that have the largest effect on length of stay and resource use in the ED. There are 2 primary throughput phases in the model. The first phase includes triage, room placement, and the initial provider evaluation. Several investigators have identified new strategies for ED triage, a function that currently varies widely across the country.<sup>20</sup> Standardization of ED triage would facilitate a common understanding of ED patient workload. Some EDs have created innovative processes for rapidly placing patients in rooms and initiating the physician evaluation. Several successful EDs routinely complete triage and room placement within 10 minutes of patient arrival and the initial physician evaluation within 10 minutes of room placement.<sup>21</sup>

The second phase of the throughput component includes diagnostic testing and ED treatment. In an efficient ED, this phase typically will constitute the majority of a patient's total ED throughput time. Several factors affect throughput times during this phase, including the cohesiveness of patient care teams, physical layout of the ED, nurse and physician staffing ratios, efficiency and use of diagnostic testing (eg, laboratory, radiology), accessibility of medical information, quality of documentation and communications systems, and availability of timely specialty consultation. Although this list is by no means exhaustive, it identifies many important areas for improving ED efficiency.

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## OUTPUT COMPONENT

Inefficient disposition of ED patients contributes to crowding for admitted and discharged patients.<sup>8</sup> The most frequently cited reason for ED crowding is the

inability to move admitted patients from the ED to an inpatient bed.<sup>8,19,22-25</sup> This problem forces the ED to board admitted patients until inpatient beds are available, effectively reducing the ED's capacity to care for new patients. Boarding of inpatients in the ED has also been cited as the most important determinant of ambulance diversion.<sup>26</sup> Ongoing care for hospital inpatients that remain in the ED consumes nursing and physician resources and may delay evaluation of new patients. The causes and consequences of ED boarding of inpatients may be the most important areas for immediate research and operational strategies to alleviate ED crowding.<sup>7</sup>

Many factors contribute to inpatient boarding in the ED. Examples include a lack of physical inpatient beds; a lack of inpatient bed availability because of inadequate or inflexible nurse to patient staffing ratios, isolation precautions, or delays in cleaning rooms after patient discharge; an overreliance on intensive care or telemetry beds; inefficient diagnostic and ancillary services on inpatient units; and delays in discharging hospitalized patients to post-acute care facilities. The nursing shortage is a major limiting factor for staffed bed availability. This shortage has prompted hospitals and policymakers to develop a variety of programs for retaining and expanding the nursing workforce. The relative importance of the factors contributing to inadequate inpatient bed availability likely varies by region and hospital.

When patients are discharged from the ED, ongoing diagnostic and therapeutic services are often required. The availability of timely follow-up appointments in the ambulatory care system once again may create capacity problems; however, it now creates output bottlenecks rather than input demands for the ED. Time spent by ED providers arranging appropriate follow-up can undermine the efficiency of care and prolong ED length of stay. Furthermore, when adequate arrangements for outpatient follow-up care cannot be made, emergency physicians are more likely to admit patients to the hospital. For example, outpatient treatment may be appropriate for selected patients with transient ischemic attacks if they have reliable and timely follow-

up care. However, if appropriate follow-up care cannot be arranged, these patients are likely to be admitted, occupying inpatient beds that could have been used for other patients.

The ambulatory care access barriers experienced by vulnerable populations (eg, uninsured patients, Medicaid beneficiaries, patients who do not have a usual source of care) create dilemmas for emergency providers who are trying to arrange appropriate follow-up care.<sup>15</sup> This process can be time-consuming and inefficient, and for many patients, it is ultimately unsuccessful. Patients who are unable to obtain follow-up care often return to the ED if their condition does not improve or deteriorates. Our model illustrates this problem by bringing a subset of discharged patients back to the ED for further care. Patients who leave before completing treatment also may return to the ED. The rate of unscheduled return ED visits within 48 hours of discharge may be a useful measure of inappropriate ED discharge or inadequate access to follow-up care.<sup>8,27</sup>

#### A MODEL-DRIVEN RESEARCH, POLICY, AND OPERATIONS MANAGEMENT AGENDA

The input-throughput-output conceptual model of ED crowding may be useful for organizing a research, policy, and operations management agenda to alleviate the problem. The model illustrates the need for a systems approach with integrated rather than piecemeal solutions for ED crowding. We believe there are 4 general areas of ED crowding that require future research. First, we must develop measures of ED crowding that are valid, reliable, and sensitive to changes throughout time. Second, research is needed to identify the most important causes of ED crowding from each component of the model. Third, the effect of ED crowding on the quality of patient care must be assessed. And finally, interventions to reduce ED crowding need to be evaluated.

The development of valid and reliable measures of the factors contributing to ED crowding is the first step in developing a coherent research and policy agenda. Each component of our conceptual model contains

concepts that should be measured consistently across sites and throughout time. Within the input component, reproducible measures of the number and complexity of patients seeking ED care are needed. Where possible, these measures should reflect the local ambulatory care system's ability to deliver unscheduled care. The throughput component identifies the need to measure ED capacity, workload (ie, urgency- and complexity-adjusted occupancy rates), and efficiency across sites. Key output concepts include measurement of the hospital's capacity to admit new patients, the efficiency of the admission process (including measurement of ED boarding), and the efficiency of the hospital inpatient discharge process.

One marker of inefficient ED care that has been linked to adverse outcomes is patients who leave without completing treatment. This marker includes patients who leave the ED before being treated, those who leave after starting treatment with a physician but before their treatment is completed, and those who leave against medical advice. In studies from Los Angeles and San Francisco, CA, cohorts of patients who left EDs without being treated were followed up to document patient outcomes.<sup>28-30</sup> A small but troubling proportion of these patients ( $\leq 11\%$ ) were admitted to a hospital within 1 week of the initial ED visit, and several required emergency surgery, indicating that leave-without-completing-treatment rates might be a useful marker of adverse outcomes associated with ED crowding.

Another marker of EDs being unable to meet patient demand is ambulance diversion. An ED that diverts ambulances has signaled that it is no longer safely able to care for another critically ill or injured patient. The rapid increase in ambulance diversion throughout the country is one of the most visible consequences of ED crowding. These diversion statistics have led to many media reports and a new study of ED crowding by the General Accounting Office.<sup>19,31,32</sup> Although we did not believe that ambulance diversion was a comprehensive definition or measure of ED crowding, certainly it is an important event to monitor. We included ambulance diversion and leave-without-completing-treatment patients in our conceptual model diagram as examples



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of the consequences of ED crowding and to show how the model illustrates normal patient flow and the bottlenecks that contribute to crowding. Although these events are linked to the throughput portion of Figure 2, the underlying causes of ambulance diversion and leave-without-completing-treatment patients may be related to input, throughput, or output factors.

Although many potential causes of ED crowding have been identified, more research is needed to define their relative importance. Potential contributing factors to ED crowding exist within each component of the input-throughput-output conceptual model. The relative importance of these contributing factors may vary across hospitals and regions. By searching for causes within each component of the conceptual model, researchers are less likely to overlook important causes of ED crowding.

The development of measures and the identification of causes of ED crowding will be the basis for the most important priorities of a model-driven research and policy agenda. The first of these priorities is to better understand the relationship between crowding and the quality of care. The Institute of Medicine has adopted 6 goals for improving the quality of care that have become the focus of health systems across the country.<sup>33</sup> The Institute of Medicine report states that care should be safe, effective, patient-centered, timely, efficient, and equitable. Although emergency patients and providers can certainly provide anecdotes that describe how ED crowding appears to have compromised quality in each of these dimensions, there are no studies of how ED crowding affects patient outcomes. We do not yet understand how ED crowding affects the outcomes that have the greatest potential for motivating change: clinical outcomes, patient satisfaction, provider satisfaction, and the cost of care. Quality-of-care problems associated with crowding also extend beyond the ED to include patients who are diverted, those who leave without completing treatment, and those who avoid care altogether because of prolonged waiting times. Rigorous study of the relationship between ED crowding and the quality of patient care must be a high priority for future research.

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The final priority in the model-driven research and policy agenda is to develop and test interventions to alleviate ED crowding. The relative importance of operational versus policy solutions is not yet clear; however, both types of interventions likely will be needed. In the search for operational solutions, a fundamental question emerges: Who is responsible for the efficiency of care delivery in the hospital? To find operational solutions for crowding, medical and administrative leaders must accept greater responsibility for the efficiency of care delivery at their institutions. Hospital leaders should routinely measure key throughput and turnaround times (with accountability for meeting institutional goals), improve the efficiency of ancillary and support services, and use information technology that supports care delivery.

Policy solutions for ED crowding are also needed, yet they are more difficult to define and implement. Again, it is helpful to look at each component of the input-throughput-output model to identify how policies contribute to or alleviate ED crowding. Several changes in payment policies might improve the efficiency of patient care, provide incentives for hospitals to move admitted patients out of the ED, and improve the ability of providers to match the demand for emergency care with appropriately staffed services. For example, Medicare mandates a 3-day acute hospital stay before it will pay for skilled nursing facility care, which creates an incentive for inappropriate hospital admissions of ED patients who could be cared for in a transitional care unit or skilled nursing facility. Reforms in payment policies for clinical decision units and observation services may also be helpful.

Our conceptual model has important limitations. First, it was developed by a small group of investigators and does not represent the consensus of a large group of experts. However, the model has been presented and informally discussed at several expert panel and research meetings and has been revised according to these discussions. The model also does not capture all of the potential causes and consequences of ED crowding, nor does it quantify the relative importance of the various contributing factors. But we do not believe that suffi-

cient evidence exists to enable this type of classification, at least not beyond the opinions of providers. We have attempted to highlight the contributing factors that we believe are most important in our discussion of the model's components.

The problem of ED crowding has, to various degrees, captured the attention and energy of emergency providers, hospital administrators, policymakers, and the public across the United States. Now it is time to focus our efforts on research, policy, and operations management agendas to alleviate the problem. We believe that the input-throughput-output conceptual model provides a practical framework for these agendas. We hope the model will be useful for researchers and policymakers as they address the problem of ED crowding and ultimately help guide them to the most effective solutions.

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